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Assessment of the hardwood floodplain forests in the Rusovce and Čunovo area (Slovak Republic)

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Abstract: This paper aims to present the current state of the floodplain forests on the right hand bank of the river Danube around the villages Rusovce and Čunovo. The stands belong to the association *Fraxino pannonicae – Ulmetum* Soó in Aszód 1936 corr. Soó 1963. They represent fragments of hardwood floodplain forests with typical flora and fauna for such areas. They are important for water management, soil protection, environment protection and landscaping. This paper presents phytocoenology analysis combined with Ellenberg's bio-indication approach and species diversity calculations.

Keywords: hardwood floodplain forests, phytocoenology, ecological account, *Fraxino pannonicae – Ulmetum,* Rusovce, Čunovo.

Introduction

Floodplain forests are typical for alluvial areas of lowland rivers. At present the original dimensions of these forests have been significantly reduced due to human activity. The majority of these forests have been cut down and the territory has been extensively exploited by forestry to plant fast-growing timber species, by agriculture to cultivate crops and by building industries. Recently, the hardwood floodplain forests ecosystems of the Central Europe were described in detail by KLIMO et al. (2008) and MACHAR et al. (2011).

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The shapes of the Danube River and its flow have been modified by water management, primarily by constructing flood protection works but also by channels and dredging operations. As a consequence, the meanders have been straightened up; the flow capacity of the river has gone down and floods have been minimised. Flooding, however, is a crucially important factor for the existence and succession of natural vegetation in the river environment. All of these measures have caused there to be a small number of floodplain forests in the basins of large Slovak rivers, with their original composition of individual vegetation floors.

Floodplain forests around the villages Rusovce and Čunovo represent a preserved fragment of the original Danubian lowland vegetation. Here, the stands of hardwood floodplain forests with their rich diversity of flora and fauna dominate. These forests, being part of the protected natural area "Dunajské luhy", are valuable examples of well-preserved natural environment and, at the same time, they are suitable for recreation and sport for the inhabitants of Bratislava and its surrounding villages. Recently, MÖLDER & SCHNEIDER (2011) investigated the flora and vegetation of hardwood floodplain forests along the Danube in Central and Eastern Europe. They mapped three well-preserved hardwood floodplain forest areas – upper (Austria), middle (Hungary) and lower (Romania). The Slovak section of the Danube river basin is missing in their study. This contribution is an attempt to fill this gap and provide phytocoenological and ecological data for the first part of the Danubian floodplain forests on the right hand bank of the Danube around Rusovce and Čunovo, south of the capital Bratislava. These forests are exceptionally important for water management, landscape planning and recreation and also in terms of nature protection.

Material and methods

We selected floodplain forests that are approximately 12 km south of Bratislava and belong to the complex of alluvial forest ecosystems in the Danube drainage basin. The majority of this area is covered by hardwood floodplain forests, while the softwood floodplain forests have been preserved only in small areas, often just as non-continuous fragments around ox-bows, dredge lakes and in terrain depressions.

The land is flat, with average altitude ~130 m above sea-level. The landscape is occasionally perturbed by depressions that are leftovers of previous fleets, periodically filled with underground waters. The locality is part of the Danubian lowland (Podunajská nížina) geomorphologic unit. Phytogeographically, it belongs to the pannonian flora (*Pannonicum*) region, eu-pannonian district, xerotherm flora (*Eupannonicum*) (FUTÁK 1966). It is located in a temperate climatic region with average annual temperature around 10 ºC. The main vegetation period lasts for approximately for 6 months, from April until September (MAGIC 1986). The total average annual precipitation amounts to 500 mm/m^2 (SHMU 2011). This locality is one of the warm and dry regions of

Slovakia. The vegetation of this area is the result of climatic, as well as hydrological factors (e.g., flooding and a high level of underground water).

We performed the phytocoenological mapping of the selected territory during the vegetation season 2010 and our findings are presented in the master diploma thesis (POGÁNYOVÁ 2011). 23 phytocoenological relevés were collected during this field work and, after critical evaluation, 20 of them were used in the final synthesis. The analysis of the phytocoenological relevés were performed according to the Zürich-Montpellier school. We used the seven-point Braun-Blanquet scale for abundance. The entries for the analysis were selected according to homogeneity, appearance, age and overall status of the stand. When processing the data we also calculated the constancy (stability) of the species using a five-point scale (V: 100 – 81 %, IV: 80 – 61 %, III: 60 – 41 %, II: 40 – 21 %, I: 20 - 1 %). Map rendering was taken from the Google Earth program and the localities of the relevés were inserted into the map accordingly (Fig. 1).

Fig. 1. Satelite picture with the localities of the relevés. The inset in lower left corner indicates the study area within Slovakia

The nomenclature of taxons follows the work of MARHOLD & HINDÁK (1998). Syntaxa are classified according to MORAVEC et al. (2000), JURKO (1958) and CHYTRÝ (2003). The nomenclature of syntax is unified according to MORAVEC et al. (2000). The extent of the perturbation of the original environment was determined according to JURKO (1990).

The eco-analysis follows the indicative method of ELLENBERG (1979, 1992) using the mean indicator values published by KARRER & KILIAN (1990) and updated by KARRER (1992, 2012). Ellenberg values indicate the highest probability of occurrence or abundance of species along environmental gradients and their applicability for Central Europe was reviewed recently by DIEKMANN (2003). Although the original scale was introduced for Germany, it is generally accepted that Ellenberg's method is also applicable for other parts of central Europe, at least in nemoral and boreal regions (SEIDLING & FISCHER 2008). For each eco-indicator we calculated the spectrum of weighted averages based on the scoring of each species present in the association (JURKO 1983). The appropriate scoring, i.e. the *significance* of each species in relevé, was evaluated as the abundance converted to a numerical scale multiplied by the constancy from the phytocoenological tables.

The degree of diversity and complexity of antropophytes was estimated using a modified Kostrowicki (1970) formula $I = 100\%.G_a.P_a/(p.g)$, where p and g are the abundance and number of all species respectively, and G_a and P_a refer to the abundance and number of antropophytes. Species that could indicate changes in the original community were determined according to JURKO (1990) (synantropic species), and MARHOLD & HINDÁK (1998) (invasion species). In addition, we calculated various diversity indices for each relevé to get a clear picture of the ecological variability, stability and complexity of the association. We used *significance* in the calculation of the following indices related to the species diversity of the herb layer (E_1): Hill´s diversity index N_2 (HILL 1973), Shannon´s diversity index H (SHANNON & WEAVER 1949), Pielou´s equitability index E (PIELOU 1966) and Simpson´s index of the concentration of dominance c (SIMPSON 1949), using the modifications for the species α-diversity as suggested by JURKO (1983). A summary of the explicit formulas for these indices can be found in ČERNUŠÁKOVÁ (2011). The method (setup of source data, lookup tables, Ellenberg's indicative method algorithm and calculation of diversity indices) is implemented in the collection of attached MS-Excel worksheets and is available from the corresponding authors upon request.

Results and Disussion

We have assigned the forests between the villages of Rusovce and Čunovo to the association *Fraxino pannonicae – Ulmetum* Soó in Aszód 1936 corr. Soó 1963. This assignment is based on the analysis of the structure of their species. The association belongs to the sub-alliance *Ulmenion* Oberdorfer 1953, alliance *Alnion incanae* Pawłowsky in Pawłowsky, Sokołowsky et Wallisch 1928, order *Fagetalia sylvaticae* Pawłowski in Pawłowsky, Sokołowsky et Wallisch 1928 and class *Querco – Fagetea* Br. – Bl. et Vlieger in Vlieger 1937 (MORAVEC et al. 2000).

Danube floodplain communities have been described by several authors. An important pilot study is the doctoral thesis of JURKO (1958) who reviewed the soil and ecology conditions of forest communities in the Danube alluvium. He described in detail the associations ranging from hydrophilic communities of willow to xerotherm association *Crataegum danubiale*, including analysis of ecology relationships in these communities. UHERČÍKOVÁ (1995) used the characteristic and diagnostic species determined by Jurko in syntaxonomic classification of floodplain stands. Alluvial Danube territory was the subject of long-term monitoring related to the construction and operation of the hydroelectric power plant Gabčíkovo. The data obtained in this monitoring was used by several authors in subsequent publications edited by Ground water Consulting Ltd. (MUCHA (sc.ed.) 1995), (LISICKÝ & MUCHA (sc. ed.) 2003), (MUCHA (sc. ed.) 2004).

The communities represent pannonian forests with oak, elm and ash trees on heavy gley soil or bottom land soil. We found altogether 101 taxons, including 15 allochthonous species, 82 autochtonnous species and 4 questionable species. There are 27 species in the tree layer with an average abundance of 91%. The dominant species in the tree layer is *Fraxinus angustifolia* subsp. *danubialis*. Other species (with stability above 50%) in this layer are: *Acer campestre*, *Ulmus minor*, *Fraxinus excelsior*, *Populus* x *canescens*, *Acer pseudoplatanus*, *Populus alba* and *Quercus robur*. The stands have a well-developed shrub layer, which is typical for hardwood communities. The average abundance in the shrub layer reaches 37%, with a total number of 34 species. Approximately 50% of the shrub individuals are juvenile trees. The species with the highest stability and abundance is *Swida sanguinea*, followed by *Crataegus monogyna*, *Ligustrum vulgare*, *Padus avium* and *Viburnum opulus*. The herb layer is well-developed with an average abundance of 73%, containing 87 species with 35% of this amount being juvenile taxons of shrubs and trees. We found the vernal ephemeral species *Galanthus nivalis*, *Ficaria bulbifera* and *Anemone ranunculoides* with high abundance in Spring. Among other taxons (with abundance above 50%) there are also *Hedera helix*, *Paris quadrifolia, Stachys sylvatica, Aegopodium podagraria, Carex sylvatica, Geum urbanum, Galium odoratum, Polygonatum latifolium, Viola reichenbachiana, Brachypodium sylvaticum, Impatiens parviflora* and *Parietaria officinalis*.

The eco-analysis of this association is summarised in Fig. 2 as a compact spectrum of species preferences (weighted by their significance) with respect to Ellenberg's eco indices. There is a considerably large proportion of indifferent species with respect to light and temperature. The centre of gravity for light is broad and lies between 4 and 5, i.e. sciophilous to semi sciophilous species dominate while heliophilous species are almost absent due to a well developed and compact tree layer in all relevés. The temperature peak is sharp and located almost exclusively around mesothermophilous species with a rather small contribution of thermophilous species. In this community, oceanic to sub oceanic species are typical. Soil moisture factor exhibits a broad peak between 5 and 6, indicating a preference of mesophilous to hygrophilous species, while nitrogen content is even more widely spread from 5 to 8, from mesonitratophilous to nitratophilous species indicating an elevated nitrogen content. In general, all of the ecofactors (except L) exhibit a unimodal spectrum of weighted averages of relative species significance. Our findings in Fig. 2 correspond very well with the phytocoenology of the association *Fraxino pannonicae – Ulmetum*.

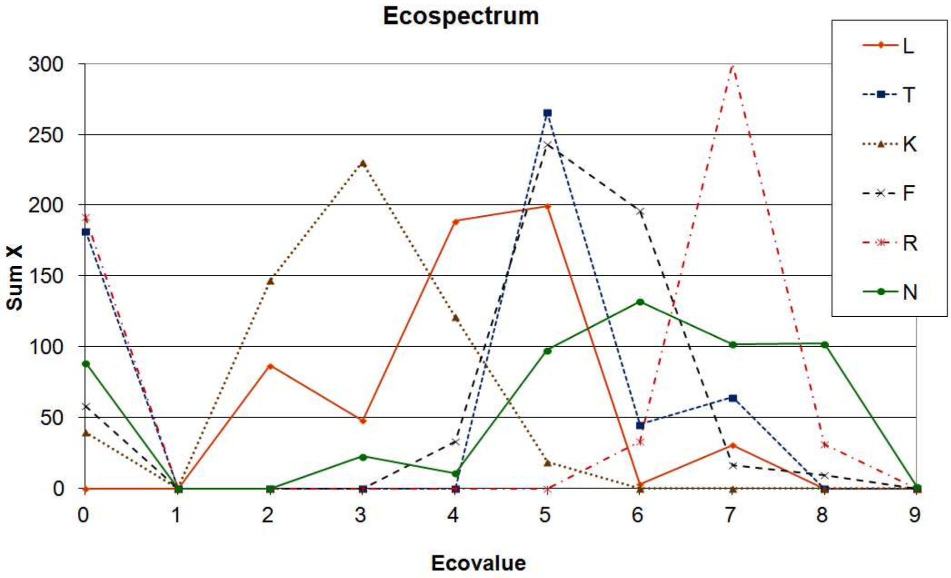

Fig. 2. Compact spectrum of species preferences (weighted by their significance) with respect to Ellenberg's eco indices (L – light, T – temperature, K – continentality, F – soil moisture, R – soil pH, N – nitrogen content).

The current state of the Danube floodplain forests can be further described in terms of the combination of diversity indices (Tab. 2). The simple diversity index I (KOSTROWICKI 1970) in conjunction with the index of diversity and complexity of antropophytes I_a can serve as a reference in the analysis of the current state of the forest. According to HALADA (1998), index I_a, may lie in the interval ⟨0, 100⟩, with 0 referring to natural community and 100 to completely synantropic. The latter index is rather small for our association, I_a = 0,15 indicating a very low degree of synantropisation.

Individual relevés exhibit I_a values in the range zero (relevés 2 and 3) to 0,58 (relevé 9). Slightly higher values of this index are coupled with increased abundance of synantropic and invasion species and, with regards to the stands with modified conditions, this is mostly due to the so called „boundary effect“. In sparsely stocked stands with transillumination one can observe a higher proportion of semi-heliophilous/heliophilous species, like invasion taxons: *Ailanthus altissima*, *Robinia pseudoacacia*, *Aster lanceolatus* and *Solidago* *gigantea*. Less frequently *Negundo aceroides* and *Celtis occidentalis* may also be observed. Among the species indicating changes to the original community we found *Impatiens parviflora* with the highest abundance. This is the only taxon that actively penetrates deeply into the forest stands, although it does not bloom in places with low luminosity.

A clearer picture of the species diversity in E_1 is provided by the diversity indices matrix in Tab. 2. and cluster analysis Fig. 3. Although the indices N_2, H, E and c consistently describe the diversity, evenness and equitability of the community from different aspects, they do not fully account for the effect of synantropic and invasion species. The only exception is relevé 9, where the increase of dominance is accompanied by a significant drop in N_2, H, E (Tab. 2). There are, however, other three disturbed stands (relevés 8, 13, 14), but their differentiation is only markedly visible in Fig. 3, where the clustering between index I_a and the concentration of dominance (Fig. 3a) or Hill's diversity index (Fig. 3b) clearly shows cluster of four stands with an increased extent of synantropisation.

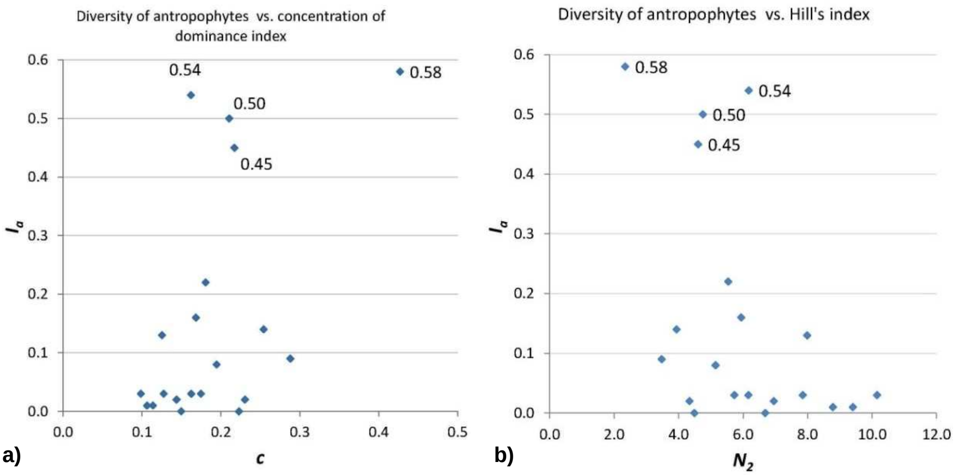

Fig. 3. Clustering of the index of diversity and complexity of antropophytes I_a with respect to Simpson's (a) and Hill's (b) indices. The additional four numbers in the top inset indicate the four largest values of the I_a index among the whole I_a set indicating the disturbed stands.

Conclusions

The forest cover in the selected alluvial area of the Danube proved to be a well preserved original forest community. The species composition analysis did not demonstrate significant changes indicating a growing process of synantropisation. The forest vegetation, syntaxomically classified as an association *Fraxini pannonicae - Ulmetum* Soó in Aszód 1936 corr. Soó 1963 was generally in good condition and an increased occurrence of invasive and synanthropic species was not proved. The most significant changes in the original forest cover had occurred as a result of intrusive intervention in the original vegetation and are visible in the overview provided by a comparison of various diversity indices. Ellenberg's bio-indication analysis provided the spectrum of species preferences for this preserved community and may be used as valuable reference data for future studies.

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Tab. 1. Phytocoenological relevés from Rusovce, Čunovo
***Fraxino pannonicae – Ulmetum* Soó in Aszód 1936 corr. Soó 1963**

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	S
Number of species in relevé	48	36	35	46	35	43	38	34	33	36	37	33	39	38	35	36	34	28	38	34	
Characteristic species of assoc. *Fraxino pannonicae - Ulmetum*																					
E_3																					
Fraxinus angustifolia subsp. *danubialis*	.	3	1	2	.	3	1	2	2	+	2	2	3	4	+	4	4	4	2	1	V
Fraxinus excelsior	3	1	r	r	.	+	3	.	1	3	.	.	.	.	1	1	1	1	3	1	IV
Ulmus minor	2	1	+	.	+	2	1	1	2	.	1	.	1	1	+	2	.	.	2	.	IV
Quercus robur	.	r	.	.	+	+	2	2	.	3	1	+	.	.	3	.	.	1	.	+	III
Populus nigra	.	.	.	r	+	.	.	.	2	2	.	.	1	.	.	.	1	.	1	2	II
Tilia cordata	.	.	+	.	.	.	+	3	.	.	.	.	.	.	.	.	.	1	.	.	I
Ulmus laevis	.	.	.	.	.	+	.	.	+	.	.	.	3	1	.	1	.	.	.	.	II
E_2																					
Ulmus minor	1	1	+	.	.	+	.	1	1	+	1	+	2	1	.	1	1	.	+	1	IV
Sambucus nigra	2	.	.	.	.	.	.	+	1	.	.	.	+	.	+	+	.	.	.	r	II
Fraxinus excelsior	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	1	1	+	II
Tilia cordata	.	.	+	.	.	.	.	+	.	r	.	.	.	.	.	.	.	.	+	.	I
Ulmus laevis	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	+	1	.	.	.	I
Fraxinus angustifolia subsp. *danubialis*	.	.	.	.	.	.	.	.	.	.	+	.	.	1	+	.	.	.	.	.	I
Quercus robur	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
E_1																					
Hedera helix	3	+	r	1	2	3	2	1	4	.	.	.	+	.	+	2	2	1	1	2	IV
Paris quadrifolia	1	3	1	+	1	+	1	3	.	.	.	+	.	1	.	1	+	+	.	.	IV
Stachys sylvatica	1	+	+	r	+	+	1	+	.	.	1	1	1	1	.	1	.	.	.	.	IV
Aegopodium podagraria	4	3	2	+	.	2	.	.	1	.	.	.	.	.	.	3	3	3	.	.	III
Quercus robur	.	.	r	r	r	.	r	.	.	+	.	.	+	.	1	.	+	.	+	.	III
Fraxinus excelsior	1	+	.	r	1	.	1	.	.	.	.	.	.	.	.	.	.	.	1	+	II
Heracleum sphondylium	1	r	r	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	II
Ficaria bulbifera	3	1	.	+	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Ulmus minor	.	.	.	r	.	.	.	.	.	+	.	.	.	.	.	1	.	.	+	1	II
Galanthus nivalis	3	3	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Anemone ranunculoides	.	.	2	.	2	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Fraxinus angustifolia	+	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	+	.	I
Tilia cordata	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	1	.	I
Alliaria petiolata	r	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
Humulus lupulus	+	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Characteristic species of suballiance *Ulmenion*																					
E_3																					
Acer campestre	+	1	+	1	+	1	2	.	2	.	.	2	1	1	+	1	2	.	1	.	IV
E_2																					
Acer campestre	.	2	.	+	.	1	.	.	+	.	+	1	.	+	1	1	2	+	1	1	IV
E_1																					
Acer campestre	1	+	.	1	1	.	2	1	.	1	1	2	+	1	.	2	1	.	1	+	IV
Viola reichenbachiana	.	+	1	.	.	.	1	1	.	.	.	1	2	2	2	2	2	2	.	.	III

Tab. 1. – cont.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	S
Number of species in relevé	48	36	35	46	35	43	38	34	33	36	37	33	39	38	35	36	34	28	38	34	
Characteristic species of alliance *Alnion incanae*																					
E_3																					
Acer pseudoplatanus	.	1	2	2	3	+	+	1	1	.	.	.	1	2	.	+	.	2	.	+	IV
Padus avium	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E_2																					
Acer pseudoplatanus	.	+	.	+	1	+	1	2	3	.	.	.	+	1	.	1	1	1	1	+	IV
Padus avium	1	1	r	.	1	.	.	.	+	.	.	.	.	.	.	.	+	.	.	1	II
Viburnum opulus	+	+	1	1	+	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	II
Euonymus europaeus	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E_1																					
Carex sylvatica	1	2	+	1	+	+	2	1	.	.	+	.	.	1	+	.	2	.	.	.	III
Acer pseudoplatanus	.	.	+	2	1	+	.	.	.	.	.	+	1	1	+	+	.	.	1	.	III
Geum urbanum	+	.	.	r	.	1	+	+	r	.	.	.	+	.	1	.	1	.	.	.	III
Padus avium	2	.	.	+	.	.	+	.	.	.	.	.	.	r	.	.	1	.	+	1	II
Pulmonaria officinalis	.	.	.	.	.	.	.	.	.	+	+	+	1	1	.	.	.	.	.	.	II
Euonymus europaeus	.	.	.	r	r	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Geranium robertianum	.	.	.	.	.	+	.	+	.	.	.	.	1	.	.	.	.	.	.	.	I
Viburnum opulus	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
Characteristic species of order *Fagetalia sylvaticae*																					
E_3																					
Acer platanoides	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	I
E_2																					
Acer platanoides	.	.	.	+	.	+	+	.	.	.	.	.	.	.	+	.	.	.	.	1	II
Corylus avellana	.	+	.	.	+	.	.	.	.	.	.	.	+	3	.	.	.	.	.	.	I
E_1																					
Polygonatum latifolium	+	r	1	+	.	2	1	1	.	.	.	2	1	+	.	1	.	1	1	.	IV
Galium odoratum	+	.	+	1	1	2	2	3	2	.	3	3	3	4	.	.	.	.	.	.	III
Acer platanoides	.	.	.	.	+	.	+	1	+	r	.	.	.	.	.	+	.	1	.	1	II
Corylus avellana	.	.	.	.	+	.	.	.	.	.	r	r	.	+	.	.	.	.	.	.	I
Characteristic species of classis *Querco - Fagetea*																					
E_3																					
Swida sanguinea	.	.	.	r	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
E_2																					
Swida sanguinea	+	2	.	1	1	.	+	.	+	4	3	2	.	1	2	+	1	+	+	1	IV
Crataegus monogyna	1	+	.	.	.	1	r	.	r	1	1	2	.	+	+	1	1	1	1	r	IV
Lonicera xylosteum	r	.	.	1	+	r	.	.	.	.	.	.	.	.	.	.	+	.	+	.	II
E_1																					
Rubus fruticosus	2	.	.	1	+	.	.	1	1	+	+	+	.	+	+	+	1	1	.	.	IV
Crataegus monogyna	+	.	.	+	.	+	.	+	.	.	.	2	.	.	1	.	.	1	+	.	II
Swida sanquinea	.	.	.	.	+	+	+	.	.	1	.	1	.	.	.	1	.	.	1	.	II
Brachypodium sylvaticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2	+	+	+	1	II
Convallaria majalis	.	2	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	1	+	.	II
Melica nutans	.	.	.	.	.	.	.	.	.	.	.	2	2	2	.	.	.	.	.	.	I

Tab. 1. – cont.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	S
Number of species in relevé	48	36	35	46	35	43	38	34	33	36	37	33	39	38	35	36	34	28	38	34	
Sanicula europaea	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	I
Lonicera xylosteum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	I
Neottia nidus - avis	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	I
Another species																					
E_3																					
Populus x *canescens*	3	+	2	+	2	.	2	+	1	.	4	4	.	.	.	.	1	.	3	4	IV
Populus alba	+	.	+	+	+	1	+	2	.	.	+	+	.	.	+	.	.	2	.	.	III
Salix alba	2	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	+	II
Robinia pseudoacacia	.	.	.	.	.	.	.	2	.	+	.	.	.	.	.	.	.	.	.	1	I
Salix fragilis	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Cerasus avium	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	r	I
Juglans regia	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	I
E_2																					
Ligustrum vulgare	1	2	+	.	.	.	.	+	.	2	1	1	1	.	.	.	.	.	+	.	III
Clematis vitalba	.	.	+	1	.	.	.	1	.	.	.	+	.	.	1	.	.	.	2	1	II
Robinia pseudoacacia	.	.	.	r	.	.	.	.	.	.	+	.	+	+	.	.	1	.	+	.	II
Berberis vulgaris	.	.	1	.	.	.	.	.	.	+	.	+	1	.	.	.	.	2	3	.	II
Populus alba	.	.	.	+	+	+	.	.	.	.	+	.	.	.	.	.	+	.	.	.	II
Juglans regia	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	+	+	.	+	.	II
Ailanthus altissima	r	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.	.	I
Philadelphus coronarius	.	.	.	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Tilia platyphyllos	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
E_1																					
Ligustrum vulgare	.	1	.	+	+	1	+	+	r	1	1	.	+	.	+	.	+	+	1	r	IV
Impatiens parviflora	.	.	.	.	.	1	.	1	2	.	+	+	2	2	1	1	1	.	.	.	III
Parietaria officinalis	.	.	.	.	.	r	.	.	+	.	.	.	3	1	3	2	1	.	.	+	II
Viola canina	.	.	.	1	1	.	+	1	.	.	.	+	.	.	.	.	.	.	2	.	II
Viola odorata	.	.	.	+	.	.	.	.	.	1	1	.	.	.	.	1	.	1	1	.	II
Juglans regia	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	+	.	.	.	+	II
Populus alba	.	.	r	.	.	.	.	.	.	.	+	1	.	.	.	.	.	+	.	+	II
Clematis vitalba	.	.	.	.	.	.	.	1	+	+	1	.	.	+	.	.	.	.	.	.	II
Viola hirta	.	.	.	.	.	1	.	.	+	1	1	.	.	.	.	.	.	.	.	.	I
Epipactis helleborine	.	.	.	.	.	.	.	.	.	r	+	+	.	.	r	.	.	.	.	.	I
Berberis vulgaris	.	.	.	.	.	.	.	.	.	+	+	.	+	.	+	.	.	.	.	.	I
Solidago gigantea	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	1	I
Arctium lappa	r	.	.	.	.	.	.	.	.	.	r	.	+	.	.	.	.	.	.	.	I
Viola mirabilis	r	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
Taxus baccata	.	r	.	r	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Lathraea squamaria	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Galium aparine	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
Negundo aceroides	+	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	I
Angelika sylvestris	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
Aesculus hippocastanum	.	.	.	.	.	+	.	.	r	.	.	.	.	.	.	.	.	.	.	.	I
Rosa canina	.	.	.	.	.	r	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I

Tab. 1. – cont.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	S
Number of species in relevé	48	36	35	46	35	43	38	34	33	36	37	33	39	38	35	36	34	28	38	34	
Rubus caesius	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	1	I
Chelidonium majus	.	.	.	.	.	.	.	.	r	.	.	.	.	.	1	.	.	.	.	.	I
Allium ursinum	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	I
Robinia pseudoacacia	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	I

Species in one relevé only:

E_3: *Carpinus betulus* 1/ +, *Clematis vitalba* 1/ 2, *Cornus mas* 3/ +, *Crataegus monogyna* 3/ r, *Aesculus hippocastanum* 6/ +, *Ulmus glabra* 6/ 1, *Celtis occidentalis* 18/ +, *Betula pendula* 20/ r

E_2: *Negundo aceroides* 9/ 1, *Cornus mas* 1/ 1, *Rubus fruticosus* 2/ +, *Malus sylvestris* 4/ r, *Ulmus glabra* 6/ +, *Populus* x *canescens* 8/ +, *Quercus cerris* 10/ +, *Pyrus pyraster* 10/ r

E_1: *Phragmites australis* 1/ r, *Cornus mas* 2/ +, *Thalictrum sp*. 4/ r, *Deschampsia cespitosa* 4/ r, *Poa nemoralis* 6/ r, *Cerasus avium* 6/ r, *Populus alba* 7/ +, *Linaria vulgaris* 10/ +, *Securigera varia* 10/ +, *Tithymalus cyparissias* 10/ +, *Leucanthemum vulgare* 10/ r, *Aster lanceolatus* 10/ +, *Carex alba* 10/ +, *Plantago media* 10/ r, *Stenactis annua* 11/ +, *Hypericum perforatum* 11/ +, *Ulmus laevis* 13/ +, *Stellaria media* 13/ +, *Parthenocissus quinquefolia* 15/ r, *Urtica dioica* 15/ 2, *Ailanthus altissima* 15/ +, *Galium mollugo* 19/ +, *Scrophularia nodosa* 20/ r.

Tab. 2. Diversity indices distributed among the relevés in the community *Fraxino pannonicae – Ulmetum* Soó in Aszód 1936 corr. Soó 1963

Rel.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
N^a	26	16	17	26	20	22	23	18	14	23	23	20	24	20	20	21	15	15	19	14
N_2	6.16	4.49	6.69	9.40	6.95	5.14	8.78	4.75	2.34	7.85	3.47	5.73	6.17	4.60	5.54	7.99	5.94	4.34	10.16	3.93
H	3.17	2.66	3.17	3.80	3.40	3.02	3.53	2.94	1.89	3.57	2.76	3.09	3.20	3.03	3.15	3.47	3.05	2.81	3.63	2.78
E	0.67	0.67	0.78	0.81	0.79	0.68	0.78	0.70	0.50	0.79	0.61	0.72	0.70	0.70	0.73	0.79	0.78	0.72	0.85	0.73
c	0.16	0.22	0.15	0.11	0.14	0.19	0.11	0.21	0.43	0.13	0.29	0.17	0.16	0.22	0.18	0.13	0.17	0.23	0.10	0.25
I	26.00	16.00	10.20	20.80	12.00	17.60	19.55	14.40	13.30	8.05	13.80	16.00	22.80	17.00	14.00	12.60	10.50	7.50	9.50	7.00
I_a	0.03	0.00	0.00	0.01	0.02	0.08	0.01	0.50	0.58	0.03	0.09	0.03	0.54	0.45	0.22	0.13	0.16	0.02	0.03	0.14

[a] N is the number of species in E_1 floor

Locations of relevés

1. Rusovce, 48°03'29,3" NLa., 17°08'59.5" ELo., A.: 1 0×40 m, AA: 50., AH: 30 m, AT: 30 cm, TC: E_3 95 %, E_2 7 %, E_1 100 %, 28.4.2010, DČ, AP.
2. Rusovce, 48°03'32,5" NLa., 17°09'03,6" ELo., A.: 2 0×20 m, AA: 20, AT: 15cm, TC: E_3 80 %, E_2 50 %, E_1 100 %, 28.4.2010, DČ, AP.
3. Rusovce, 48°03'36,4" NLa., 17°09'05,6" ELo., A: 20 ×20 m, AA: 50, AH: 20 m, AT: 45cm, TC: E_3 80 %, E_2 50 %, E_1 60 %, 28.4.2010, DČ, AP.
4. Rusovce, 48°03'22,8" NLa., 17°09'04,6" ELo., A: 20×20 m, AA: 20, AH: 20 m, AT: 25 cm, E_3 80 %, E_2 25 %, E_1 80 %, 28.4.2010, DČ, AP.
5. Rusovce, 48°03'15,6" NLa., 17°09'09,3" ELo., A: 20×20 m, AA: 40, AH: 20 m, AT: 40 cm, TC: E_3 85 %, E_2 30 %, E_1 60 %, 28.4.2010, DČ, AP.
6. Rusovce, 48°03'12,4" NLa., 17°09'13,6" ELo., A: 20×20 m, AA: 60, AH: 30 m, AT: 80 cm, TC: E_3 98 %, E_2 20 %, E_1 80 %, 24.5.2010, DČ, AP.
7. Rusovce, 48°03'08,8" NLa., 17°09'17,9" ELo., A: 10×40 m, AA: 150, AH: 30 m, AT: 1m, TC: E_3 95 %, E_2 10 %, E_1 85 %, (two old individuals of the trees *Quercus robur,* average of trunk 1, 3 m), 24.5.2010, DČ, AP.

8. Rusovce, 48°03'09,2" NLa., 17°09'37,03" ELo., A: 20×20 m, AA: 50, AH: 20 m, AT: 40cm, TC: E_3 85 %, E_2 25 %, E_1 80 %, 24.5.2010, DČ, AP.
9. Rusovce - Čunovské jazerá (lakes), 48°02'48,3" NLa., 17°09'55 ,6" ELo., A: 20×20 m, AA: 80, AH: 25 m, AT: 70 cm, TC: E_3 95 %, E_2 45 %, E_1 95 %, 24.5.2010, DČ, AP.
10. Čunovské jazerá (lakes), 48°02'24,5" NLa., 17°10'42 ,3" ELo., A: 20×20 m, AA: 30, AH: 15 m, AT: 15 cm, TC: E_3 95 %, E_2 85 %, E_1 35 %, 11.6.2010, DČ, AP.
11. Čunovské jazerá (lakes), 48°02'28,5" NLa., 17°10'40 ,8" ELo., A: 20×20 m, AA: 40, AH: 20 m, AT: 50 cm, TC: E_3 95 %, E_2 50 %, E_1 60 %, 11.6.2010, DČ, AP.
12. Čunovské jazerá (lakes), 48°02'28,2" NLa., 17°10'43 ,3" ELo., A: 20×20 m, AA: 50, AH: 20 m, AT: 70 cm, TC: E_3 95 %, E_2 50 %, E_1 80 %, 11.6.2010, DČ, AP.
13. Rusovce - Čunovské jazerá (lakes), 48°02'32,7" NLa., 17°10'4 0,07" ELo., A: 20×20 m, AA: 60, AH: 20 m, AT: 50 cm, TC: E_3 90 %, E_2 30 %, E_1 95 %, 11.6.2010, DČ, AP.
14. Rusovce - Čunovské jazerá (lakes), 48°02'37,1" NLa., 17°10'4 2,8" ELo., A: 20×20 m, AA: 70, AH: 25 m, AT: 50 cm, TC: E_3 95 %, E_2 50 %, E_1 85 %, 11.6.2010, DČ, AP.
15. Rusovce, 48°03'29,1" NLa., 17°09'06,5" ELo., A: 20×20 m, AA: 70, AH: 15 m, AT: 40 cm, TC: E_3 90 %, E_2 20 %, E_1 70 %, (terrain depression, probably previous distributory), 20.7.2010, DČ, AP.
16. Rusovské jazero (lake), 48°03'33,2" NLa., 17°0 9'15,05" ELo., A: 20×20 m, AA: 60, AH: 20 m, AT: 60 cm, TC: E_3 95 %, E_2 15 %, E_1 60 %, 20.7.2010, DČ, AP.
17. Rusovské jazero, 48°03'36,1" NLa., 17°09'19,0 7" ELo., A: 20×20 m, AA: 60, AH: 20 m, AT: 60 cm, TC: E_3 85 %, E_2 40 %, E_1 70 %, 20.7.2010, DČ, AP.
18. Rusovské jazero (lake), 48°03'44,5" NLa., 17°0 9'10,3" ELo., A: 20×20 m, AA: 80, AH: 20 m, AT: 30 cm, TC: E_3 95 %, E_2 40 %, E_1 50 %, (forest glade, juvenile vegetation, there are just four trees ~80 years old persisting from the original vegetation, 20.7.2010, DČ, AP.
19. Rusovské jazero (lake), 48°03'40,3" NLa., 17°0 9'07,5" ELo., A: 20×20 m, AA: 50, AH: 15 m, AT: 20 cm, TC: E_3 95 %, E_2 50 %, E_1 50 %, 20.7.2010, DČ, AP.
20. Rusovce, 48°03'12,2" NLa., 17°09'45,6" ELo., A: 20×20m, AA: 40, AH: 15 m, AT: 15 cm, TC: E_3 85 %, E_2 40 %, E_1 50 %, (narrow fragment of the wet wood in relatively inaccessible place), 13.10.2010, DČ, AP.

Abbreviations:

A – area, **AA** – average age of the forest, **AH** – average height of the trees, **AT** – average thickness of the trees, **TC** – total cover in $E_3/E_2/E_1$, **NLa**. – northern latitude, **ELo**. **–** eastern longitude, DČ – Danica Černušáková, AP – Andrea Poganyová.

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